Economic Benefits of the Michigan Department of Transportation's 2006–2010 Highway Program

FINAL REPORT

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Prepared by

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and

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The statements, findings, and conclusions herein are those of the authors and do not necessarily reflect the views of the project sponsor.

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1. Introduction

The purpose of this study is to conduct an economic benefit analysis of the Michigan Department of Transportation's current Five-Year Highway Program. Through this program, MDOT makes substantial investments in the highway system throughout the state of Michigan, spending approximately $1.4 billion annually on the preservation, maintenance, and enhancement of the state's road and bridge system.

A well-maintained and efficient transportation system provides the backbone for all economic activity within Michigan. Investment in transportation thus results in economic benefits for Michigan overall as well as for its industry sectors individually. Included in our assessment is the estimation of the transportation-related benefits of the program: time-savings for households and businesses, and investment in construction and engineering. The resulting value to Michigan's macroeconomy is then derived. These results are shown in comparison with a base case, that is, allowing the state's road and bridge infrastructure to wear down as a consequence of not funding MDOT activities.

The economic impact is assessed both for Michigan's overall economy and for its major industry sectors. Included are two sectors that MDOT has earmarked for particular attention: manufacturing and tourism (and by extension, the balance of the total economy, consisting of the nonmanufacturing sector excluding tourism). The aggregate economic impacts are measured as follows: (1) in terms of various labor market indicators such as changes in employment, labor force, and unemployment; (2) with monetary variables such as changes in compensation and personal income; and (3) by the most comprehensive measure of output, Gross State Product (a state measure comparable to Gross Domestic Product for the nation). The industry sector impacts are measured in terms of jobs. As indicated below, the economic effects of the program will include estimates of its spin-off benefits, as generated by the REMI (Regional Economic Models, Inc.) model of the Michigan economy.

REMI is probably the most widely applied regional economic forecasting and policy analysis tool in the nation. The methodology was first initiated in the mid-1970s by G. I. Treyz, A. F. Friedlander, and B. H. Stevens (Economics Department, University of Massachusetts), and a core version of the model was then developed for the National Academy of Sciences. REMI was subsequently established in 1980, and since then has been developing models that answer "what if" questions about the effect of policy initiatives on the economy of local regions. The model has been generalized for all counties and states in the United States, or any combination of counties and states. The University of Michigan has been using various versions of the REMI model since 1983 to assess projects for several state government agencies in Michigan. The model is based on past and current research and development, which is subject to peer review and published in academic journals.

The model is currently used by hundreds of governmental agencies, universities, utilities, and private consulting firms for forecasting and policy analysis in areas including:

- Transportation infrastructure investments
- Forecasting and planning
- Regional economic development programs
- Environmental improvement projects
- Energy and natural resource conservation programs
- State and local taxation, budget, and welfare policy changes

The model is constructed to respond in a logical way to changes in any of these areas.

REMI is especially well-suited for assessing initiatives such as MDOT's Highway Program because: (1) the model is structured to compare the consequences of policy initiatives with a base case absent these changes; (2) the model is very detailed, able to capture the complexities of interactions among economic sectors in response to a policy change; and (3) the model has a regional focus, for instance, taking account of the "leakage" outside of the state of a portion of the economic activity stimulated by a local policy change. Central to the current MDOT study is the estimation of the spin-off

benefits to the Michigan economy of the Highway Program in addition to its direct benefits. The REMI model is designed to generate such estimates. Spin-off effects come from two sources: indirect effects, or purchases from local suppliers (e.g., steel, concrete, professional services); and expenditure-induced effects, or spending by people who receive income attributable to transportation-policy-related activity (e.g., spending by realtors of income received from selling homes to construction workers). It is the sum of the direct and spin-off activities that determines the total effect of MDOT's investments on the Michigan economy. More detail on the model and procedures is provided in section 2.3.

MDOT provided much of the initial input data. The Economic Development Research Group (an independent consulting firm located in Boston, Massachusetts) took primary responsibility for estimating the time and cost savings that result from the program, and apportioning program-related spending in Michigan in such a way that the economic model could interpret it. The University of Michigan's Institute of Labor and Industrial Relations took primary responsibility for generating the estimates of the economic benefits of the program that derive from the inputs. The two units did work as a team, though, each contributing to both phases of the project.

The following sections summarize the inputs into the economic model, including cost savings and transportation investments; the modeling methodology; and the results of processing the inputs through the economic model. This is the second such economic impact study commissioned by MDOT, using the most complete information available as well as state-of-the-art research tools. The present study is an update of a similar study carried out last year by the same team of researchers.

2. Methodology

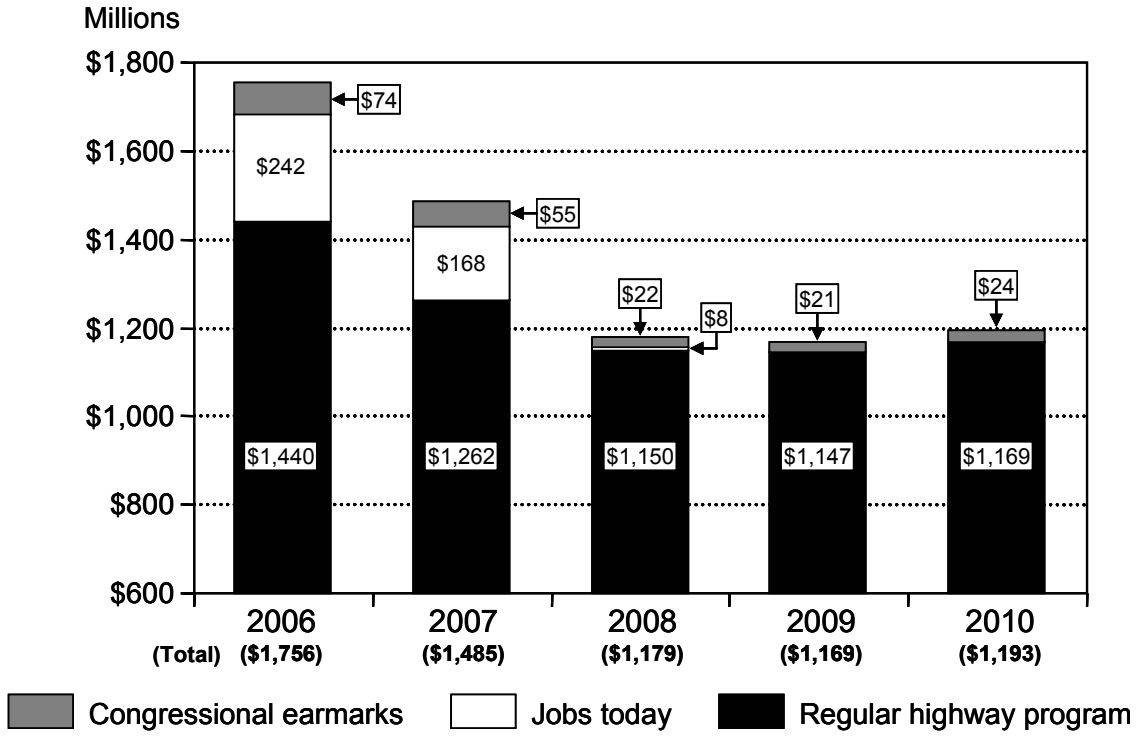
The general approach to determine the benefit of pursuing trunkline road and bridge system improvement was to take annual state-level program data provided by MDOT, and in combination with information and parameters considered as standard for this

type of analysis, generate: (1) mappings of program expenditures into the appropriate policy levers for the REMI economic model; (2) estimates of annual travel-time savings for households and businesses (valued for each specific trip class) in terms of vehicle-hours of travel; and (3) the economic benefits accruing to the Michigan economy and its major industry sectors from these program expenditures and travel-time savings. The procedures underlying each of these stages are summarized briefly in the following three subsections.

2.1 Mapping MDOT Five-Year Program Expenditures

MDOT provided annual state-level highway program investment data (on a current-year dollar basis) for the interval 2006 through 2010, as shown in figure 1. Included in the investment totals shown in the figure are the amounts attributable to Governor

Figure 1
MDOT Five-Year Highway Program,[1] Jobs Today, and Congressional Earmarks
FY 2006 to FY 2010 Investment Levels



[1]MDOT Highway Capital Program investment includes routine maintenance.

Granholm's Jobs Today initiative announced in November 2005 and congressional earmarks contained in the recently passed federal reauthorization transportation bill. More detail is provided in table 1, which shows both the annual average and the five-year total investment distributed among all program subcategories. The federal aid revenue estimate used to develop the 2006−2010 Five-Year Highway Program is based on the recently passed federal reauthorization bill known as SAFETEA-LU (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, enacted August 10, 2005, as Public Law 109–59). It is projected that $3.8 billion in federal aid obligation authority will be made available to the trunkline capital program for this Five-Year Highway Program.

The state aid revenue estimate used to develop the 2006–2010 Five-Year Highway Program is based on MDOT's share of the fiscal-year 2005 and 2006 Michigan Transportation Fund (MTF) as estimated by the Michigan Department of Treasury, Economic and Revenue Forecasting Division. Future-year state revenue is forecast using a long-range forecasting model developed by MDOT, Statewide Transportation Planning Division.

MDOT's state transportation revenues available from the state trunkline fund (STF), including routine maintenance, are estimated at $2.781 billion during the 2006–2010 Five-Year Highway Program time frame.

This Five-Year Highway Program also includes new bond revenue. Approximately $260 million in new bonds is scheduled for 2006 to support the Preserve First initiative. MDOT will also invest approximately $600 million in additional bonding to support funding for Governor Granholm's Jobs Today initiative and the implementation of SAFETEA-LU earmarks. The new bonding will be in the form of Grant Anticipated Revenue Vehicle (GARVEE) notes.

Annual detail on these investment data pertains to the following funding categories: *repair and rebuild of existing roads, maintenance, bridges, capacity improvements and new roads, safety programs, other,* and *routine maintenance*. For all categories except *routine maintenance*, MDOT assumed that 20 percent of the budgeted amounts would

Table 1
MDOT Five-Year Highway Program
FY 2006 to FY 2010 Investment Levels

	Annual Average ($ millions)	Five-Year Total ($ millions)
Repair and maintain roads and bridges		
Repair and rebuild roads		
Preserve rehabilitation and reconstruction[1]	421	2,107
Non-freeway resurfacing	8	40
Passing relief lanes[1]	6	30
Capital preventive maintenance	107	533
Total repair and rebuild roads	**542**	**2,710**
Repair and rebuild bridges		
Preserve rehabilitation and reconstruction	133	663
Capital and scheduled preventive maintenance	35	178
Big Bridge	18	88
Special needs[5]	3	15
Blue Water Bridge	3	15
Total repair and rebuild bridges	**192**	**959**
Routine maintenance	**278**	**1,391**
Total repair and maintain roads and bridges	**1,012**	**5,060**
Capacity improvements[2] and new roads		
Capacity improvements[1]	87	434
Research capacity improvements	6	28
New road construction[1]	6	32
Research new roads	4	20
Border infrastructure program	22	110
Total capacity improvements and new roads	**125**	**624**
Safety program[6]		
Signs	14	67
Markings	13	67
Guardrail and attenuators	5	26
Signals	9	44
Safety program	19	96
Total safety program	**60**	**300**
Congestion mitigation and air quality	**30**	**150**
Intelligent transportation system	**12**	**61**
Other		
Other federally funded programs[3]	59	294
State programs[4]	59	293
Total other	**118**	**587**
Total five-year trunkline program	**1,356**	**6,782**

Source: Estimated capital outlay program template

1. Projects list included in the Five-Year Transportation Program document. Preserve First and Jobs Today projects included.
2. A substantial portion of capacity improvement projects includes the preservation of the existing road.
3. Other federally funded programs include enhancement, railroad crossing, safe routes to schools, noise abatement, and other programs.
4. State programs include Transportation Economic Development Fund – Category A, advanced ROW acquisition, Michigan Institutional Roads program, non-discretionary "M" program, State Railroad Crossing program, program development, and scoping.
5. Bridge special needs includes emergency bridge repair items found during inspection.
6. Additional safety funds are utilized in other programs such as road rehabilitation and reconstruction, bridges, capacity improvements, and new roads.

be spent on *planning and engineering*. The balance would be spent on construction activities. *Routine maintenance* involves no *planning and engineering* component.

MDOT also provided guidance on *planning and engineering* activities. For each relevant category, they provided the allocation to planning versus engineering. For both the *planning and engineering* component and the *construction* component, we have information from MDOT regarding the extent that contractors perform category-specific projects versus work performed by MDOT employees. These allocations, shown in table 2, were time-invariant.

Table 2
Apportioning Program-Related Spending

	P/E Component of Annual Cost	% of P/E $ to		% of Construction $ to	
		Contractors	MDOT Staff	Contractors	MDOT Staff
Repair and rebuild roads	20%	55%	45%	100%	0%
Maintenance	20%	20%	80%	50%	50%
Bridges	20%	60%	40%	100%	0%
Capacity improvements and new roads	20%	70%	30%	100%	0%
Safety program	20%	60%	40%	95%	5%
Other programs	20%	60%	40%	90%	10%
Routine maintenance	0%	na	na	0%	100%

Another important piece of information provided by MDOT concerns the prevalence of Michigan contractors engaged in MDOT programs. For *planning and engineering*, 95 percent of the contractors are Michigan-based, and for *construction*, 88 percent. Contractors from outside Michigan would fulfill the balance of the contracted activities**,** as shown in table 3.

Table 3
Summary of MDOT FY 2005 Construction Contracts
% of Work Performed by Michigan Contractors

	2005 FY Total	% of Total Contracts
Michigan contractors	$963,278,616	88
Out-of-state contractors	$131,988,632	12
Total	$1,095,267,248	100

We combine the information on what types of activities are performed and what sectors perform them with the information on how much is directly awarded to businesses in Michigan. We do this to calibrate the program-related expenditures to the values that serve as inputs into the REMI economic model. These inputs are specified as REMI policy variables, and they form the policy-initiated changes that are processed through the model to simulate the effects of the program-related expenditures on the Michigan economy and its major sectors.

2.2 Travel-Time Savings Related to Program Improvements

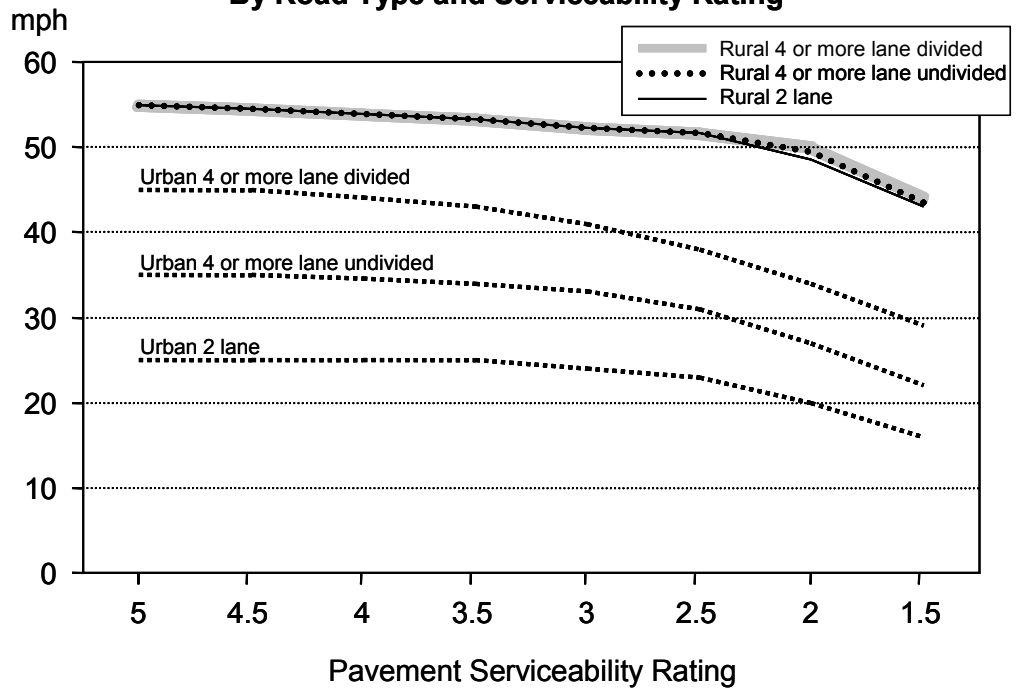
A key assumption used in the assessment of travel-time savings was the correlation of pavement condition and vehicle speed. Limited research has shown that there is a correlation in real traffic performance with ride-quality and pavement condition. Generally, past research has shown that free-flow speed falls as ride-quality deteriorates (Zaniewski 1982). Very small speed reductions occur with slight worsening of ride-quality, and speed begins to fall off noticeably as ride-quality declines to "poor." For this study, MDOT estimated that speeds on free-access roads fell by 2½ m.p.h. on pavements with "poor" ride-quality, and by 5 m.p.h. on limited-access freeways with "poor" ride-quality. Severe reductions of 10 m.p.h. or more may be observed on very poor pavements, but these are unlikely to occur on the state trunkline system.[1]

The relationship between the change in vehicle speed and the change in pavement quality, for specific road types, is shown in figure 2. The change in VHT associated with the MDOT program is estimated based on this relationship.

As part of this study, MDOT isolated the implied changes in vehicle hours traveled (VHT), by MDOT region, associated with making the improvements proposed in the Five-Year Program. These changes (annual increments, not cumulative) are shown in

[1]FHWA guidelines for assessing pavement quality are from their published recommendations (U.S. Department of Transportation, Federal Highway Administration 2004).

Figure 2
Average Vehicle Speeds
By Road Type and Serviceability Rating



Source: "Life-cycle Analysis for Pavement Management Decision-making Methodology Development" by Texas Research and Development Foundation, September 1985
Adapted from McFarland and Zaniewski

table 4 and are contrasted against each region's VHT estimates under the existing road conditions (and the implied future deterioration).[2]

MDOT provided a region-specific traffic composition table for 2004 (see table 5), which describes the percentage of annual VHT in a region by *commercial* vehicles. Combining the region-specific traffic composition with the information in table 4, summing over all MDOT regions, we were able to estimate VHT saved for both *commercial* and *auto* categories. Table 5A shows how these VHT savings accumulate over time.

[2]During the analysis of the 2006–2010 regional VHT savings, it was discovered that MDOT underestimated these savings on all freeway facilities included in the report preceding this one, released in January 2005. This underestimation resulted from the department's estimating only one direction of VHT savings on freeway facilities. Thus, the current estimates of VHT savings for work on freeway facilities are slightly higher than those reported last year.

Table 4
Daily Vehicle Hours Traveled (VHT) Savings Expected from Improved Pavement Conditions
(From projects within MDOT's 2006–2010 Highway Program)

Region	Year	Daily VHT (Representative of existing conditions) For 2006-10 Project Segments Only	Daily VHT (Representative of conditions following pavement reconstruction)	Expected Daily VHT Savings as a Result of Improved Pavement Conditions For 2006-10 Project Segments Only
Bay	2006	11,456.87	10,687.36	769.52
Bay	2007	19,584.36	18,208.07	1,376.29
Bay	2008	4,427.06	4,147.75	279.31
Bay	2009	6,902.38	6,414.00	488.38
Bay	2010	5,658.04	5,259.10	398.94
			Bay Region 2006-2010 Cumulative Savings:	**3,312.43**
Grand	2006	6,337.93	5,923.47	414.46
Grand	2007	7,409.64	6,869.94	539.70
Grand	2008	7,428.32	6,930.26	498.06
Grand	2009	10,504.85	9,636.63	868.22
Grand	2010	6,266.56	5,781.17	485.39
			Grand Region 2006-2010 Cumulative Savings:	**2,805.83**
Metro	2006	28,694.78	26,834.19	1,860.59
Metro	2007	69,311.22	63,856.22	5,455.00
Metro	2008	20,163.24	18,942.64	1,220.60
Metro	2009	42,312.17	39,058.90	3,253.27
Metro	2010	15,702.23	14,678.01	1,024.22
			Metro Region 2006-2010 Cumulative Savings:	**12,813.68**
North	2006	4,512.91	4,267.93	244.98
North	2007	6,327.85	5,964.01	363.84
North	2008	3,800.27	3,577.67	222.60
North	2009	4,101.12	3,867.57	233.55
North	2010	1,925.23	1,833.87	91.36
			North Region 2006-2010 Cumulative Savings:	**1,156.33**
Southwest	2006	7,553.41	7,025.06	528.35
Southwest	2007	13,349.34	12,508.82	840.52
Southwest	2008	15,744.89	14,691.11	1,053.78
Southwest	2009	11,338.52	10,583.22	755.30
Southwest	2010	6,222.44	5,810.28	412.16
			Southwest Region 2006-2010 Cumulative Savings:	**3,590.11**
Superior	2006	1,191.06	1,118.83	72.23
Superior	2007	5,050.48	4,764.36	286.12
Superior	2008	2,681.00	2,555.28	125.72
Superior	2009	5,375.24	5,119.63	255.61
Superior	2010	3,232.93	3,041.96	190.97
			Superior Region 2006-2010 Cumulative Savings:	**930.65**
University	2006	11,891.59	11,238.43	653.16
University	2007	7,408.24	6,961.52	446.72
University	2008	9,030.20	8,478.13	552.07
University	2009	5,895.25	5,585.84	309.41
University	2010	7,935.59	7,374.11	561.48
			University Region 2006-2010 Cumulative Savings:	**2,522.84**
			Total All Region Savings:	**27,131.87**

Sources: MDOT Statewide Model and MDOT MAPSCORE Database

Table 5

Traffic / Vehicle / Trip Composition

Region	Annual VMT 2004	Annual Commercial VMT	% Commercial VMT
Bay	6,774,064,592	543,379,200	8.0%
Grand	6,018,605,773	511,856,657	8.5%
Metro	18,723,383,867	1,187,042,887	6.3%
North	4,176,408,304	341,230,802	8.2%
Southwest	6,025,531,963	969,109,929	16.1%
Superior	2,195,439,122	206,359,324	9.4%
University	9,810,833,664	1,166,898,956	11.9%

Table 5A

Cumulative Annual VHT Savings, 2006–10

Year	Commercial	Auto
2006	–180,432	–1,951,901
2007	–451,160	–5,078,664
2008	–599,234	–6,373,120
2009	–788,050	–8,434,065
2010	–895,486	–9,481,677

This annual series of VHT saved must be allocated appropriately (and valued) before measuring the added economic benefit to Michigan businesses and households. Table 5B presents the 2005 trip table for Michigan. The *origin-destination* composition of trips on the state's roads affects how much of annual VHT saved is awarded to the Michigan business or household sectors. These are discussed in section 3.1.

Table 5B Annual Trips in Michigan, 2005		
	Commercial	Auto
Total number of trips	44,361,546	10,749,413,155
Origin-destination		
Michigan to Michigan	51.4%	98.7%
Michigan to/from other states	45.4%	1.3%
Thru-trips	3.2%	0%
Auto Trip—Purpose		
Commute	Non-home-based to work	Personal
22.9%	4.8%	72.3%

In addition, for *autos*, table 5B also shows trip-purpose breakout. With this trip profile, auto VHT savings can be allocated among households (for *personal* and *commuting*) and businesses (for *on-the-clock*[3] and a portion of their employees' commuting). The implications of this are also presented in section 3.1.

It should be noted that the commercial trip table for 2003 used in this year's study is much different, in both *origin-destination* make-up and STCC allocation, from the 2000 table used in last year's study. This has an important effect on the profile of the industry savings allocation, and thus on the industrial composition of employment effects reported in section 3.2.

The value of travel-time savings for business is mapped into the appropriate policy variables in the REMI model after adjusting for the local (Michigan) benefit. The data are entered into the policy variables by industry, and REMI treats the business savings as reductions in production costs for those industries. The changes in these policy

[3]On-the-clock travel refers to trips made by workers during their work day as part of the job. The cost of this excess travel-time is borne by business and is valued at the worker's wage plus fringe/overhead costs.

variables (known as COSPOLs[4]) are processed through the model to simulate the effect on the Michigan economy of travel-time savings for business.

Several sets of COSPOL variables are introduced into the REMI model to represent reduced cost of doing business among several categories of industry travel-time savings, including: (1) an industry's savings related to truck-transported freight (sensitive to the *origin-destination* aspects with respect to Michigan's borders), and (2) an industry's savings when its employees' *on-the-clock* times improve, and when its employees have shorter commute times. For the latter, it is recognized in the economics of labor markets that employers share a portion of their workers' commuting costs as capitalized in the wages they must offer to attract the necessary labor, as longer and more difficult commutes translate into wage premiums.[5]

The industries encompassed in category (1) above are those captured by MDOT's commodity flow summary compiled from the 2003 Transearch Database provided by Global Insight, Inc. (2005). For the same *origin-destination* pairings, Transearch data describe, for the year 2003 and a projection for 2013, the number of trucks and tons by commodity type, classified by Standard Transportation Commodity Code (STCC). STCC groupings are readily mapped into Standard Industrial Classification (SIC) industry categories. For each industry implicitly represented in the Michigan Transearch data, the truck share for 2003 is used to allocate Michigan commercial vehicle savings for each year.

The industries encompassed in category (2) above focus on services with *on-the-clock* requirements, and all private-sector industries with respect to workers' commute time savings. Allocation of the annual savings due to *on-the-clock* travel is based on the service industry's employment share of total service sector employment in Michigan.[6]

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[4]COSPOL is shorthand for production cost policy variables in the REMI model. Values of these policy variables can be altered to change the production costs of particular industries. They are used when a specific policy will affect the cost of doing business in a region without directly changing the relative costs of factor inputs (i.e., labor, capital, or fuel).

[5]Retail, construction, and nonprofits were judged to be industries that do not have to pay a wage premium to attract workers who have difficult commutes within the state.

[6]For this calculation, the insurance industry is included in services.

The allocation of commute-related savings is based on an industry's employment share of total private-sector employment in Michigan.

Finally, the travel-time savings to households (including savings related to *personal trips* and one-half of *commute trip* savings) is modeled at 50 percent of the savings, using the REMI model's *quality of life* (non-monetary amenity) policy variable.

2.3 REMI Economic/Demographic Model and General Procedures

As indicated in section 1, to estimate the effect of MDOT's Five-Year Highway Program on the Michigan economy, we use an economic/demographic model constructed by Regional Economic Models, Inc. (REMI) of Amherst, Massachusetts, and adapted by the research team at the University of Michigan for the purposes of this study. The REMI model has been fully documented and peer-reviewed in the professional literature (Treyz 1993, Treyz et. al 1992). The REMI model has been designed particularly for carrying out simulations of the type generated for this study, and has been used nationwide for such studies over the past two decades.

The industry interactions associated with the presence or absence of an activity are captured by input-output methods, which identify the buying and selling relationships among a fairly detailed breakout of industries. The REMI model is much more complex than its input-output component, though, having a very detailed calibration of the workings of the macroeconomy.

The general procedure in estimating the economic effect of the MDOT Highway Program is to adjust the model so as to add the specific MDOT capital improvement program and then to have the model generate the economywide impact, including the spin-off effects. As stated earlier, it is the sum of the direct and spin-off activities that determines the total effect of MDOT's investments on the Michigan economy.

For the purpose of the current analysis, the base-case forecast for Michigan allows the state's road and bridge infrastructure to wear down during the period 2006–2010 as a

consequence of not funding MDOT activities. The underlying projection of state government employment represents a slower growth in staffing than would be needed when developing and implementing the Five-Year Program. We then add the program to the baseline, to determine hypothetically how different the economies would be.

The details underlying the general modeling methodology are more complex. To the extent possible, the model inputs were tailored to the specific program components, rather than being generic representations of the components. Adjustments were made to avoid double-counting activities. Care was taken to distinguish those activities that bring in funding from outside of the state from those that involve spending redirected within Michigan. A case in point is tourism. With the cooperation of the Michigan Department of Labor & Economic Growth (MDLEG), we recalibrated some of the industry results in the model to isolate the impacts on out-of-state tourism, a sector not explicitly broken out in the REMI model. A predecessor to MDLEG carried out a special study to identify those industries that would in some part constitute tourism under the Standard Industrial Classification system (Michigan Employment Security Commission 1980). We were able to take that industry list, and for each of those industries, separate out the portion that was related to out-of-state tourism by using current information in the REMI model (these portions are identified in the note at the bottom of table 7).

3. Results

3.1 Travel-time Savings Related to Program Improvements

Implementation of the projects within MDOT's Highway Program is estimated to provide Michigan with the following travel-time savings over the period 2006–2010 (all values are stated in inflation-adjusted 2004 dollars):

(1) Automobiles realize the greatest amount of VHT savings; 98.7 percent are trips fully contained within Michigan. The balance are with an origin or destination in Michigan. About 23 percent of these VHT savings are related to trips between home and work, with another 4.8 percent being non-home-based work-related trips

(we call these *on-the-clock* or OTC). The balance of the automobile trips are non-work-related (or personal).

(2) Michigan households realize travel-time savings worth $14.6 million (2006) to $71 million (2010) per year, using the standard of valuing an hour of an individual's time at one-half the wage of $18, or $9 (U.S. Department of Transportation, Office of the Secretary 1997).[7] The 2010 savings are reflective of 1.27 hours saved annually per adult in Michigan. This considers time saved for commuting as well as personal trips.

(3) Michigan businesses share part of the savings associated with employees' commute times, and the full amount of the OTC. These are worth between $3.7 million (2006) and $17.8 million (2010) per year.

(4) Michigan businesses reap savings related to their commercial VHT savings. The standard used here is $50 per hour in vehicle operating costs.[8] These savings would be between $6.6 million (2006) and $33.1 million (2010) per year.

(5) Combining (3) and (4), Michigan businesses are set to save between $10.3 million (2006) and $51 million (2010) per year.

3.2 Economic Effect on Michigan of MDOT's Program

The tables and figures in this section show our estimates of the economic effect on Michigan of MDOT's Five-Year Highway Program, compared with the scenario of allowing the state's road and bridge infrastructure to wear down during 2006–2010 as a consequence of not funding the activities. The underlying projection of state government employment represents a slower growth in staffing than would be needed

[7]Since the data provided were for annual increments, the inputs are cumulative, with the larger amounts in each range pertaining to the last year analyzed.
[8]Multi-region annual study by Transport Canada (2000), published value for 2000 U.S. Great Lakes region, $42.46 U.S., updated to 2004 using data published by the U.S. Department of Energy, Energy Information Administration, on diesel prices; and annual wage growth documented in a study by the Wyoming Department of Employment, Planning and Research section (2001), contrasting national trends.

for the program. The results reflect the total effect of the program, including the spin-off effects from program activity. The aggregate economic effects are represented in table 6 by employment, population, number of unemployed, labor force, value of shipments (sales), Gross State Product, and categories of personal income.[9] The industry effects presented in table 7 focus on employment. The results are shown annually for the duration of the program.

MDOT plans to spend $1,756,000,000 on the program in 2006, as shown previously in figure 1. MDOT's expenditures decline over the next three years of the plan so that for 2008–2010, they average only $1,180,000,000 annually in current-year dollars. Adjusted for inflation, expenditures decline more rapidly, from $1,698,000,000 (2004 dollars) in 2006 to average $1,084,000,000 yearly from 2008 to 2010.

As shown in figure 3, the program is forecast to generate 30,824 jobs in Michigan in 2006. The employment impact declines over time, reaching 18,284 in 2010.[10] Expenditures per job in 2006 amount to $55,100 (2004 dollars). The benefits that accrue to the state from the Five-Year Highway Program extend beyond 2010, outside of our period of analysis.

Several other metrics gauging the economic benefits of MDOT's expenditures are shown in table 6. During 2006–2010, under the base case, Michigan is forecast to see a continued outmigration of residents. MDOT's expenditures are projected to reduce the number of residents leaving the state by 6,223 in 2006 and 2,150 in 2010 compared with the situation without the program, reflecting a stronger economy and a positive

[9]Employment represents the total number of private and public sector jobs, including the self-employed. Population includes all residents, civilian and military. Labor force consists of the employed and unemployed, where the unemployed are actively seeking work. Gross State Product is a state measure comparable to Gross Domestic Product for the nation. Personal income is the income of Michigan residents from all sources, after deduction of contributions to social insurance programs but before deductions of income tax and other personal taxes.

[10]Note that the job gains are not cumulative; that is, the job gains in 2006 and 2007 are not added to the gains in 2008 to determine the total job gain in 2008. The only cumulative results shown are the monetary values reported in the final column of table 6, and in figures 4 and 5.

Figure 3
Effect on Employment of MDOT's Five-Year Highway Program
2006–2010

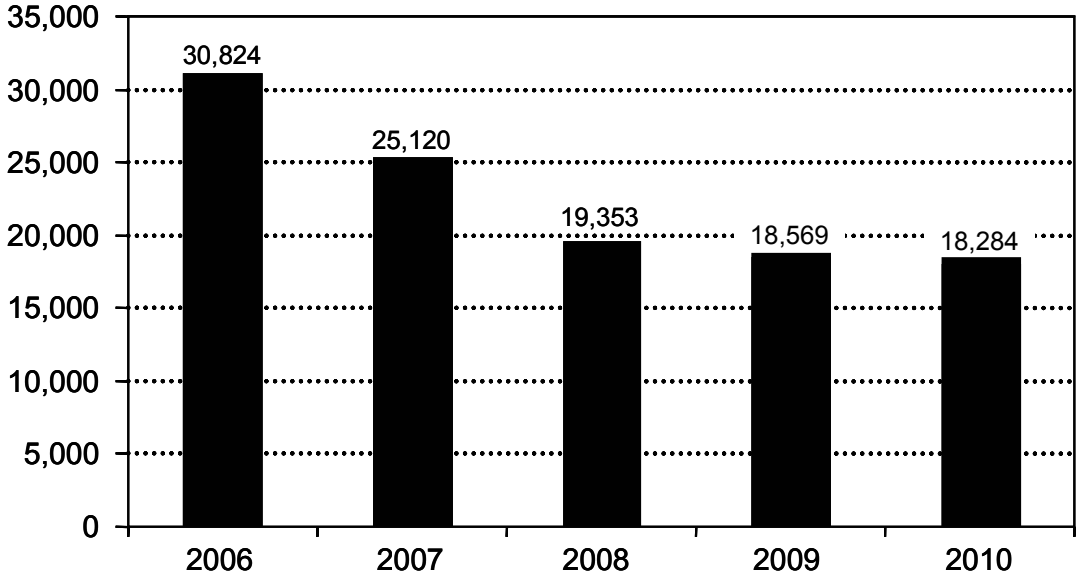


Table 6
Economic Benefits of MDOT's Five-Year Highway Program
2006–2010
(Changes compared with baseline forecast)

	2006	2007	2008	2009	2010	Total 2006-10
Total employment	30,824	25,120	19,353	18,569	18,284	–
Population	6,388	10,860	13,800	16,530	19,010	–
Reduction in outmigration	6,223	4,276	2,704	2,441	2,150	–
Number unemployed	–24,510	–15,709	–8,603	–6,679	–5,424	–
Labor force	6,314	9,411	10,750	11,890	12,860	–
Value of shipments (millions '04 $)	3,353	2,741	2,105	2,027	2,010	12,236
Gross State Product (millions '04 $)	1,832	1,524	1,197	1,168	1,174	6,895
Real personal income (millions '04 $)	1,165	1,004	829	843	867	4,708
Labor & proprietors' income (millions $)	1,406	1,231	997	986	992	5,612
Less: Social insurance taxes (millions $)	85	74	60	59	59	337
Plus: Non-labor income (millions $)	-75	-19	34	64	93	97
Equals: Total personal income (millions $)	1,246	1,138	971	991	1,026	5,372

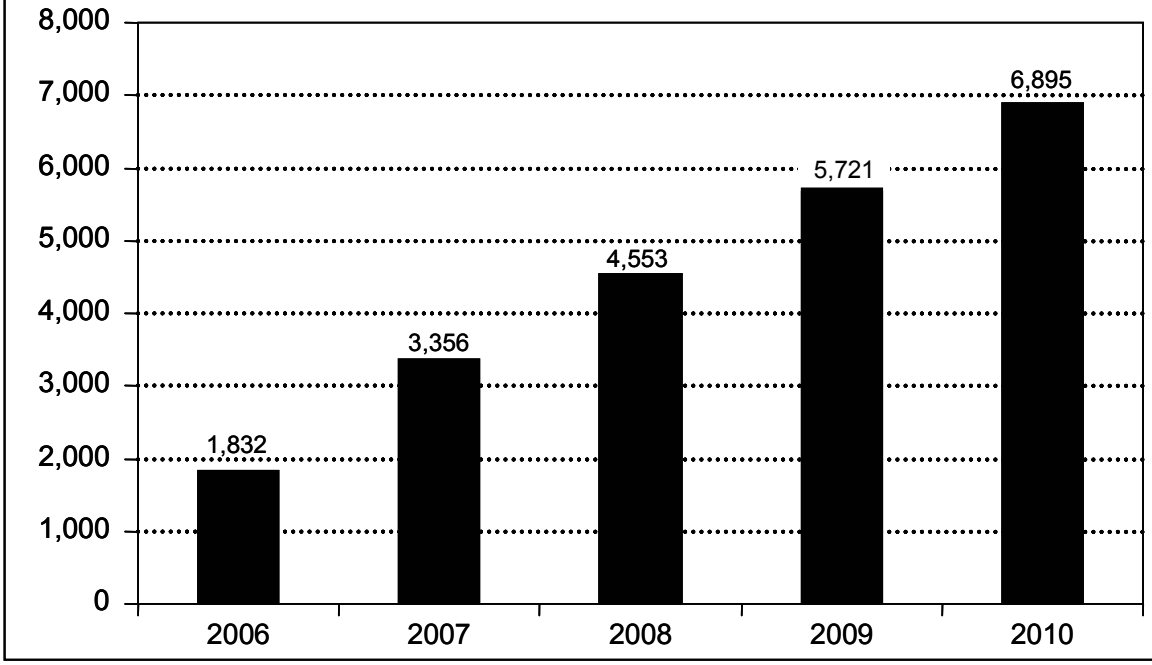
Source: REMI model version 5.5; includes amenity effect, household time savings valued at $9.00 (approximately 1/2 the hourly wage rate).

amenity effect (i.e., Michigan as a more attractive place to live). The slower rate of outmigration contributes to a higher population than predicted by the baseline forecast, 6,388 higher in 2006 and 19,010 higher by 2010.

The impact of the program is to reduce the number of unemployed workers by about 24,500 in 2006 and by more than 5,400 in 2010 compared with the base case. The labor force is also greater and growing over time, mostly because outmigration of the working-age population has been reduced. The total value of shipments is greater by $3.353 billion (2004 dollars) in 2006, while the real Gross State Product (GSP) is increased by $1.832 billion.[11] As shown in figure 4, the real GSP benefits cumulate from 2006 to 2010, to $6.9 billion. A portion of the value-added, or GSP, benefits becomes personal income tied to the additional jobs created.

Figure 4
Cumulative Effect on Real Gross State Product of MDOT's Five-Year Highway Program, 2006–2010

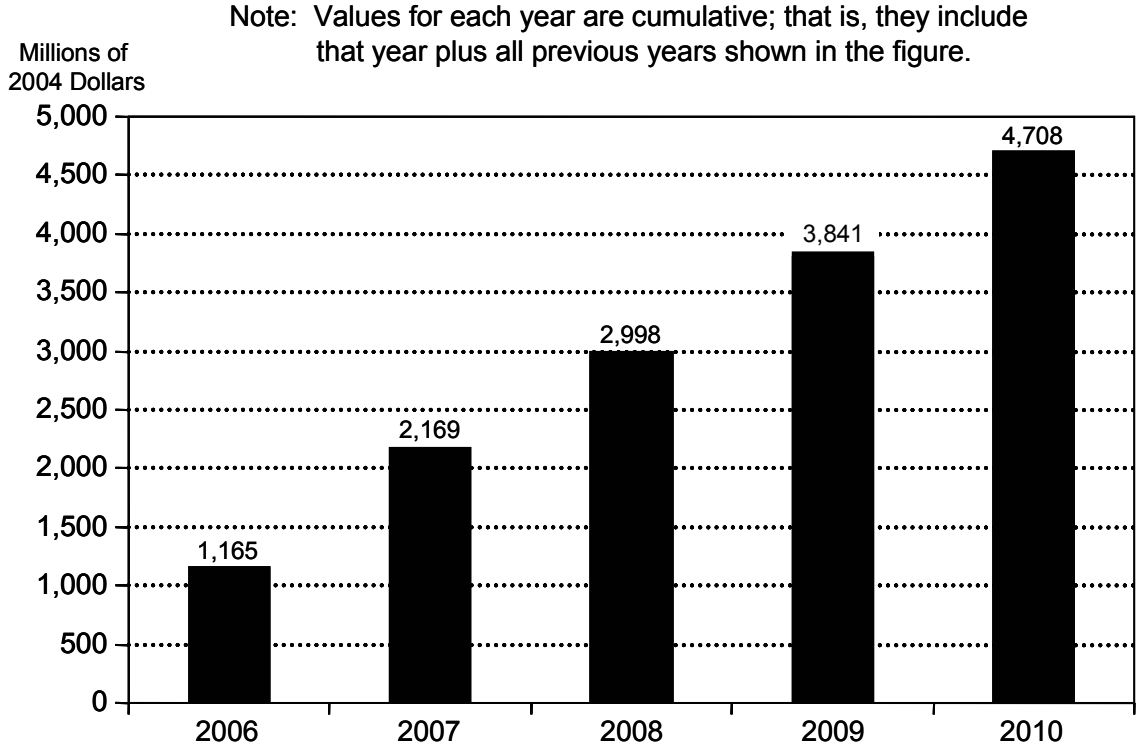
Note: Values for each year are cumulative; that is, they include that year plus all previous years shown in the figure.



[11]Note that the value of shipments exceeds the GSP because the shipments measure includes the value of intermediate goods and services, while GSP includes only the value added by Michigan firms.

As shown in table 6, real personal income (2004 dollars) is increased by $1.165 billion in 2006, and by $867 million in 2010. This moderation in real income benefits over the time period (–25.6 percent) is not as pronounced as the moderation in employment benefits (–40.7 percent) or real expenditures (–36.6 percent) over the same period. The smaller moderation in income effects over time reflects three factors: (1) a decline in unemployment and welfare payments results in a negative contribution from non-labor income for 2006, but by 2010, this negative contribution is more than offset by an increase in dividend, interest, and rental income, resulting in a positive contribution; (2) higher real wages due to economy-wide productivity growth; and (3) the economic contribution of a better transportation network cumulates over time, and will extend beyond the time period examined in this report. As shown in figure 5, the real income benefits cumulate from 2006 to 2010, to $4.7 billion.

Figure 5
Cumulative Effect on Real Income of MDOT's Five-Year Highway Program
2006–2010



The employment benefits of MDOT's Five-Year Highway Program are distributed across major industry divisions and years in table 7. Again, the estimates represent direct and spin-off employment, and the totals for each year duplicate the total employment effect reported in table 6. As shown in the table, the largest job gains are in construction, which includes the direct employment of highway construction workers, and in professional services, reflecting the employment of engineers and other professional workers.

Table 7

Employment Benefits of MDOT's Five-Year Highway Program By Industry, 2006–2010

(Changes compared with baseline forecast)

Industry	2006	2007	2008	2009	2010
Total employment	30,824	25,120	19,353	18,569	18,284
Manufacturing	1,340	1,006	693	618	582
Out-of-state tourism	358	284	210	199	193
Nonmanufacturing exc. tourism	29,126	23,830	18,450	17,752	17,509
Construction	11,700	9,594	7,467	7,148	7,013
Professional services	4,000	3,176	2,308	2,191	2,147
Business services	2,099	1,715	1,296	1,222	1,180
Trucking	162	130	98	93	92
Other	11,165	9,215	7,281	7,098	7,077

Note: Out-of-state tourism consists of air transportation (54.5%), hotels (65.6%), recreation (11.4%), eating and drinking (8.0%), other retail (5.0%), and auto repair (2.9%).

MDOT's focus industries, the manufacturing and out-of-state tourism sectors, make up almost 20 percent of the jobs in Michigan's economy. In addition to contributing over a million jobs, manufacturing and tourism are two of the state's leading export-base sectors, drawing in income from the rest of the country as well as from the rest of the world. The Highway Program creates 1,340 jobs in manufacturing in 2006, and 358 jobs in out-of-state tourism.[12]

[12]The "Other" designation in table 7 includes the following major industry categories: (1) mining; (2) transportation except trucking and part of air transportation, communication, and public utilities; (3) wholesale and retail trade; (4) finance, insurance, and real estate; (5) health, private educational, and personal services except part of hotels; and (6) government.

The differences in industrial composition between last year's and this year's study are largely (but not entirely) driven by changes in the effects of commercial VHT savings and how these savings are allocated across industries as production cost savings. These savings are allocated across industry divisions in part by using the Transearch commercial trip table, and as noted in section 2.2, the table used in this year's study (2003 version) is much different from the table used in last year's study (2000 version). This is *predominantly* what is causing the different profile of industry savings allocation. Changes in both the pattern and the scale of investment spending over the five-year period also affect the results in terms of magnitude and industry distribution.[13]

For context, the total number of jobs attributable to the program in 2006 amounts to about 0.6 percent of total employment in the state. None of these estimates include the nonmeasurable effects and intangible advantages that would produce additional economic benefits for Michigan.

While the MDOT program activities have been presented in terms of their economic impact on Michigan, this does not represent the full value to the state's residents and businesses. The primary advantages are human and social. A well-maintained surface transportation system that operates efficiently can generate air quality benefits that improve health and quality of life. A safer surface system reduces the number of fatal and non-fatal accidents for all users of Michigan's roads and bridges, residents and visitors alike. The prevention of auto-related injury and death is the most compelling reason for upkeep and improvement of infrastructure.

[13]The pattern influences the results over such a short time period because of short-term responses to the inputs built into the economic model. In terms of scale (besides obvious changes in the total magnitude of effects), if there is a change across studies in the relationship between the investment effects and production cost savings driven by commercial VHT savings, the share of industry employment in the total impact would change (an example would be construction employment, which is heavily tied to investment spending).

4. Conclusion

MDOT makes substantial investments to maintain Michigan's complex infrastructure network, dedicating approximately $1.4 billion annually for the preservation, maintenance, and enhancement of the state's road and bridge system. These transportation investments result in economic benefits both for Michigan overall and for its industry sectors individually. In this study, we conduct an economic benefit analysis of MDOT's current Five-Year Highway Program, using the most complete information available as well as state-of-the-art research tools.

We find that Michigan households realize travel-time savings worth $14.6 million to $71 million per year between 2006 and 2010, and Michigan businesses save between $10.3 million and $51 million per year. These time savings, combined with program expenditures on construction and engineering projects, result in economic benefits accruing to Michigan. In 2006, there are 30,824 jobs created in Michigan due to the program, over $1.8 billion in Gross State Product (GSP) is generated, and about $1.2 billion in personal income is produced (the latter two measures are stated in inflation-adjusted 2004 dollars). Over the duration of the program, from 2006 to 2010, the inflation-adjusted GSP benefits cumulate to $6.9 billion, and real personal income benefits sum to $4.7 billion.

As important as the economic contributions are, the primary advantages of the program are human and social. Of these advantages, none is more significant than the enhancement of safety. Jobs are replaceable, lives and time are not. With MDOT's Highway Program, Michigan's economic health is improved along with the public's safety and quality of life.

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